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Wilson

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(54) **MARINE PROPULSION UNIT**

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(22) Filed: **May 26, 2005**

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Related U.S. Application Data

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(60) Provisional application No. 60/289,352, filed on May 8, 2001.

(51) **Int. Cl.**
B63H 1/14 (2006.01)
B63H 11/00 (2006.01)

(52) **U.S. Cl.** **440/49**; 440/53; 440/75; 440/112

(58) **Field of Classification Search** 440/112, 440/51, 54, 56, 58, 59, 60, 75
See application file for complete search history.

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(57) **ABSTRACT**

A marine propulsion unit utilizing a turbine engine is provided as a drop-in module. The propulsion unit includes a base which forms a part of the hull. The propulsion unit includes a drive unit which is mounted to the engine. Both the engine and the drive unit are moved with respect to the hull to change the angle of the propeller with respect to the hull. A hydraulic resistance system is provided to provide resistance to a turbine engine when in an idle condition. An auxiliary power transfer is provided to power an auxiliary gen-set and power unit. A main electrical power unit having an auxiliary engine is also connected to the power transfer unit. The auxiliary engine may be used to drive the vessel at low speeds and maneuvering conditions. One of the main engines may be used to drive both of the shafts through the power transfer unit.

4 Claims, 10 Drawing Sheets

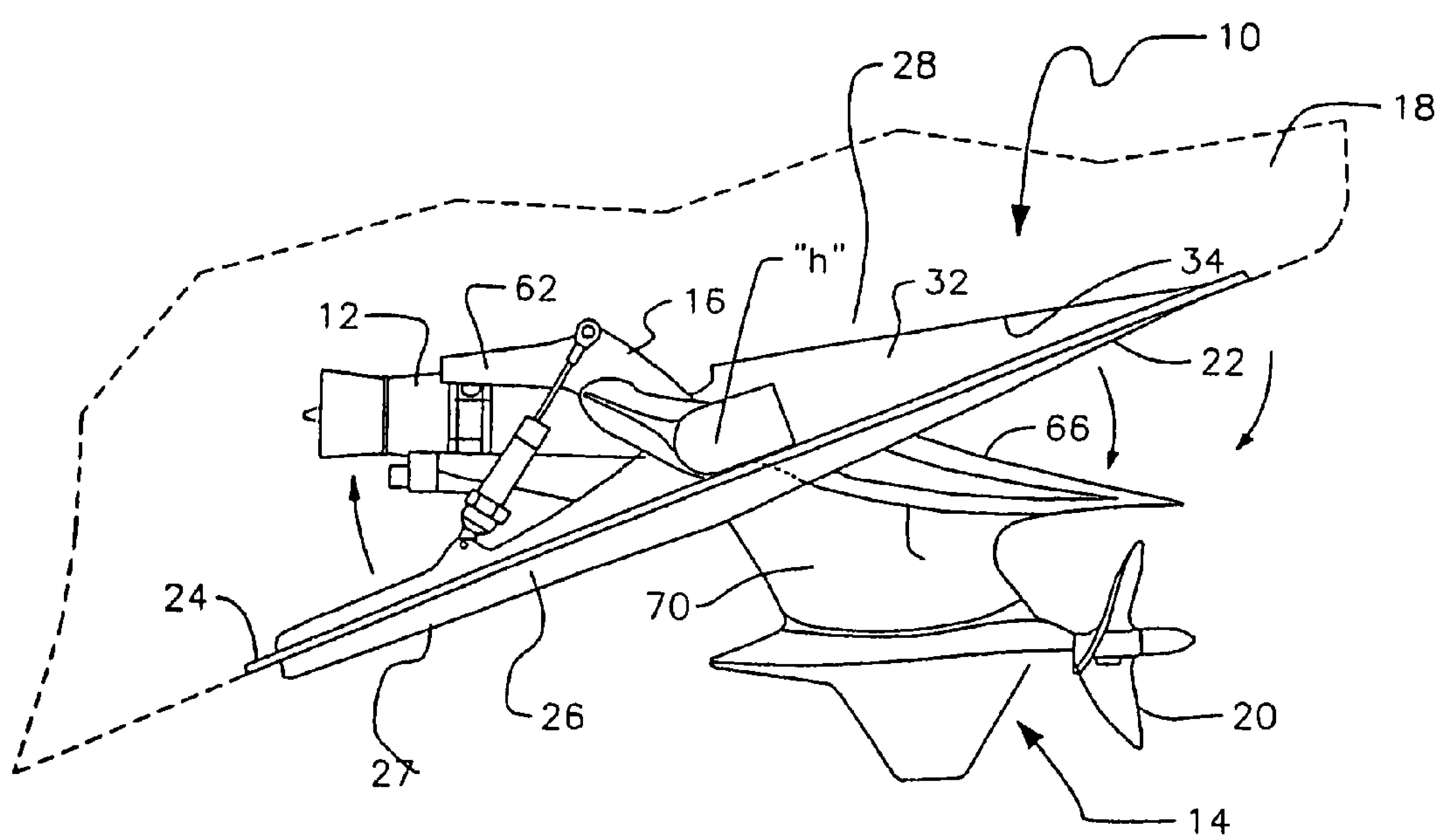


FIG. 1A

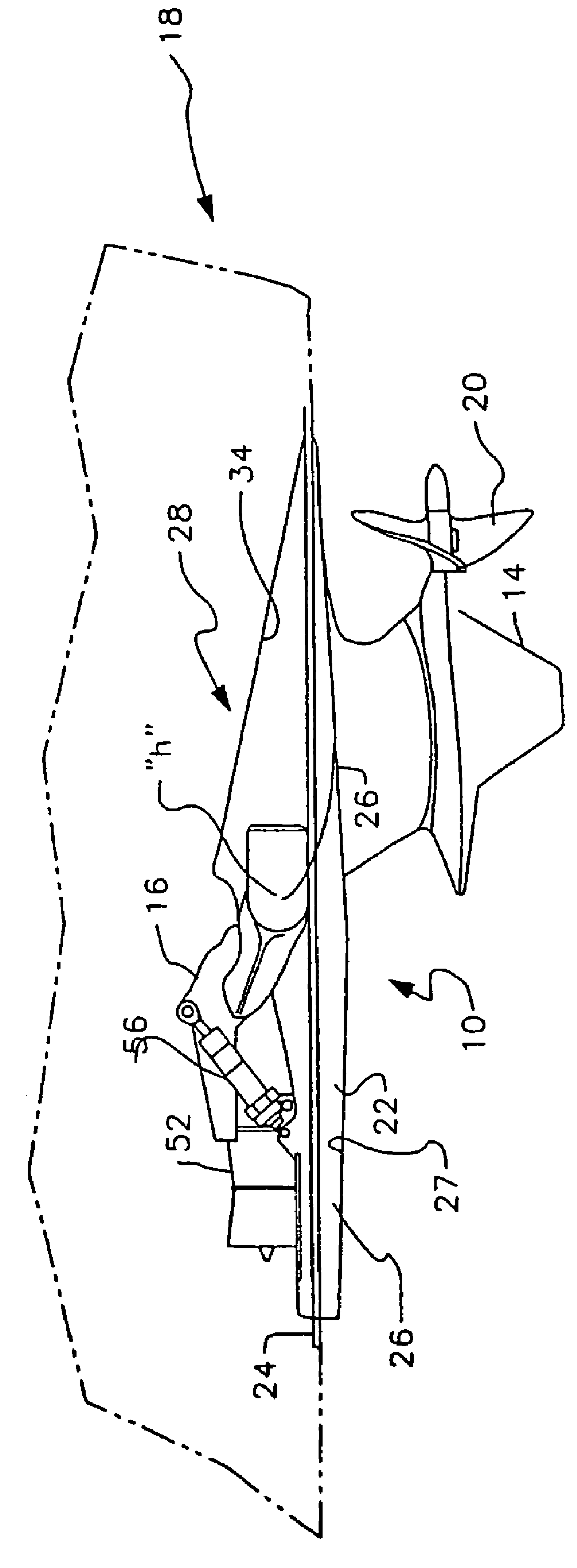


FIG. 1B

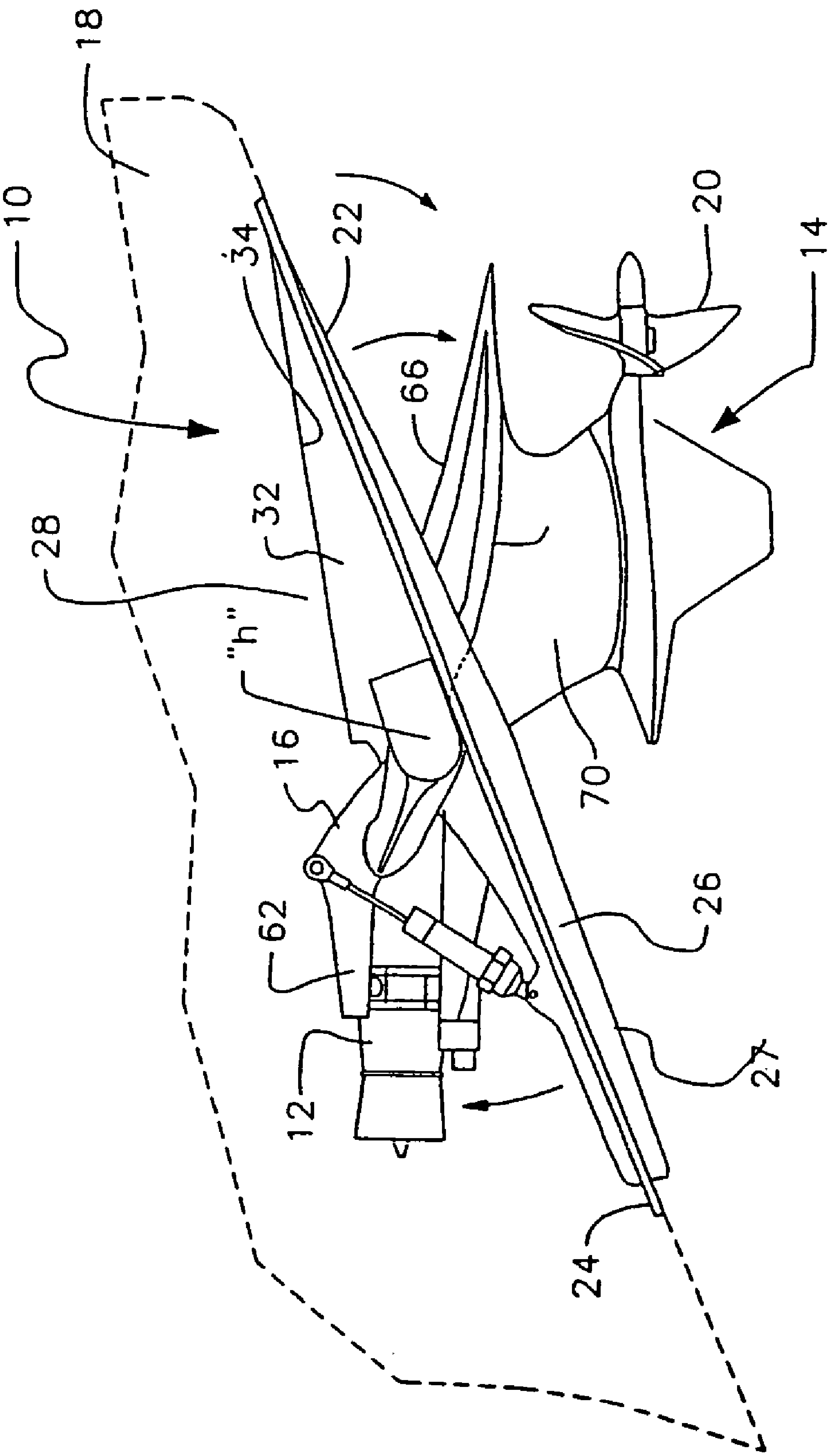


FIG. 2

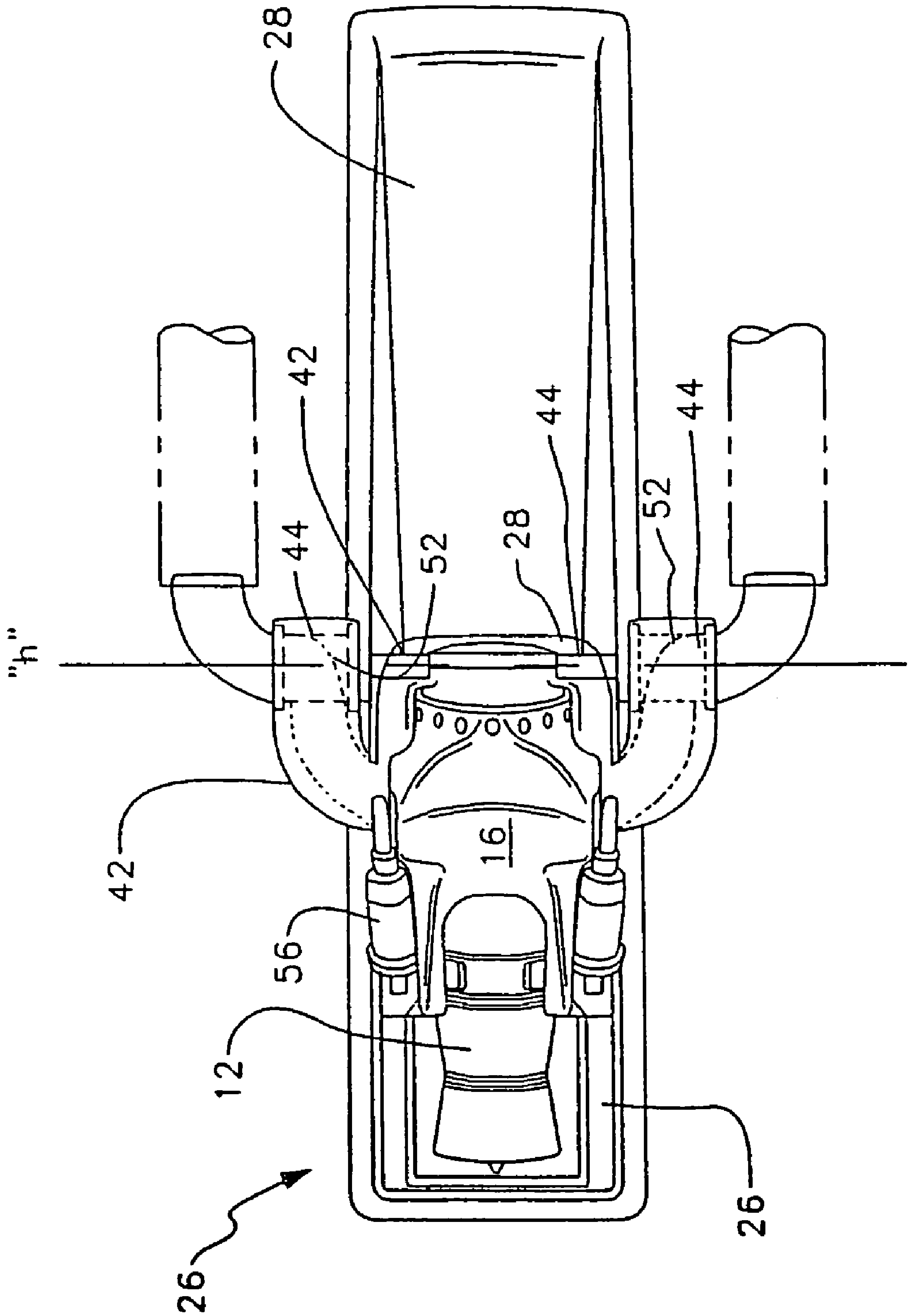


FIG. 3

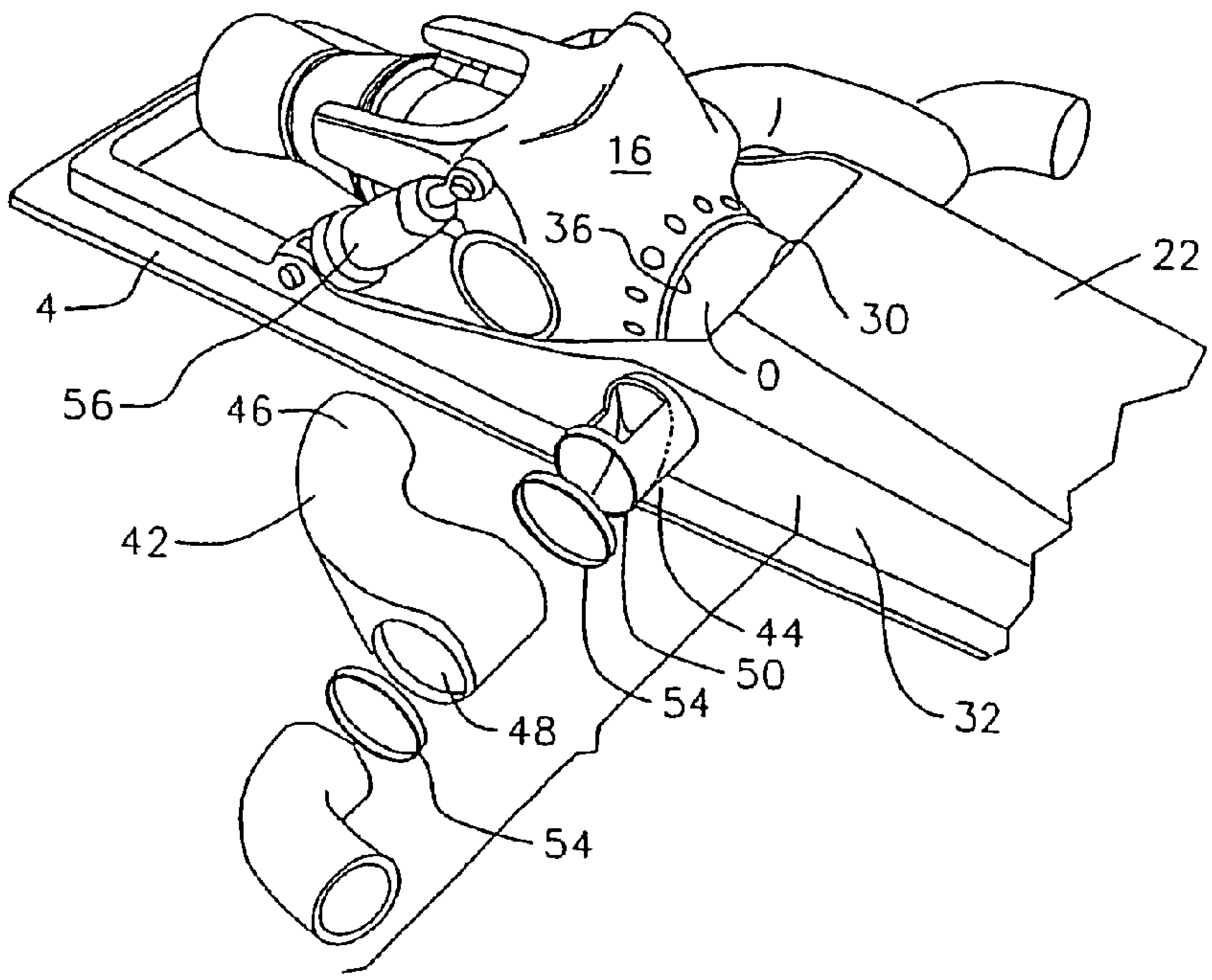

16
36
22
30
4
0
56
46
42
44
50
54
32
48
54

FIG. 4

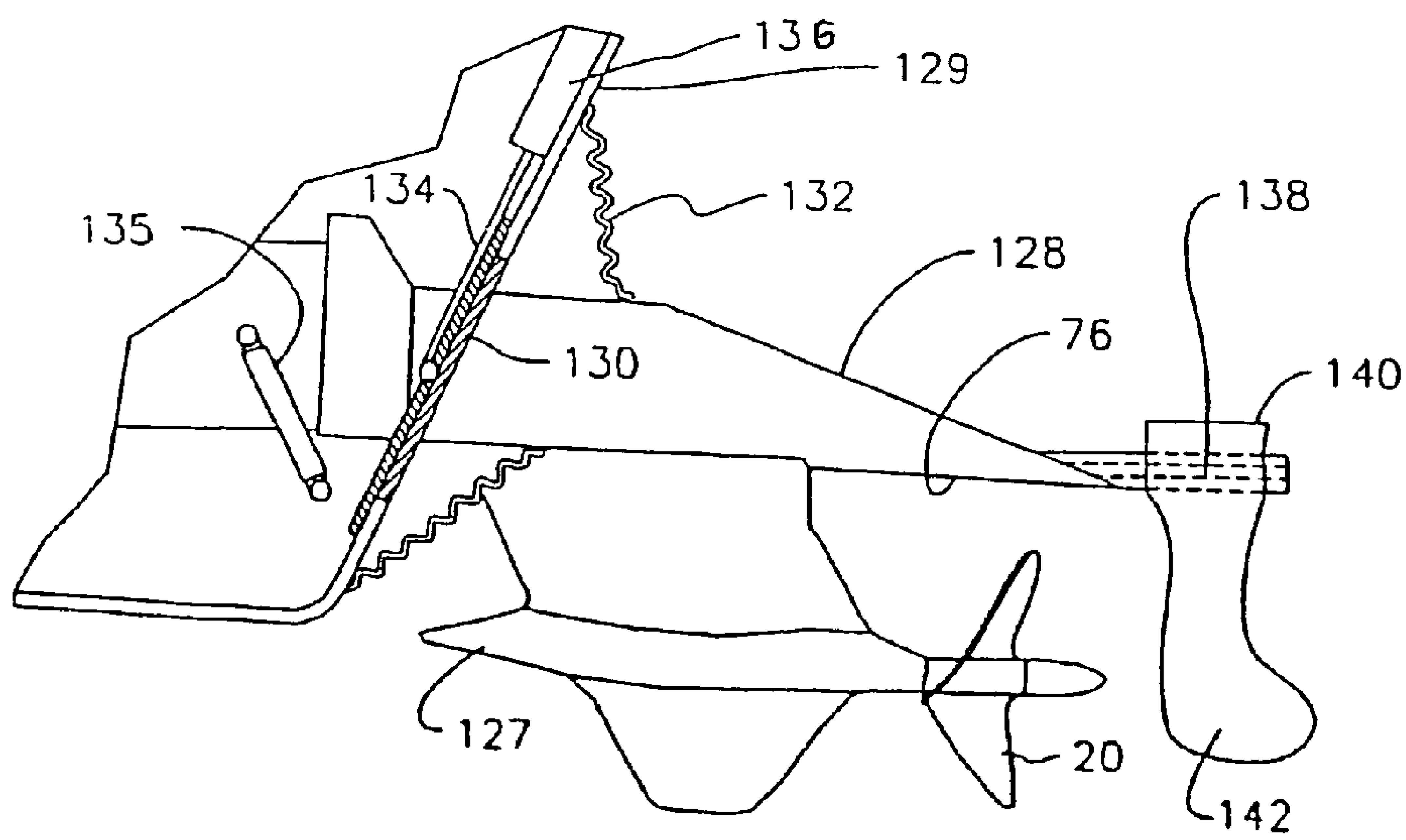

136
129
134
132
135
128
138
76
140
130
127
20
142

FIG. 5A

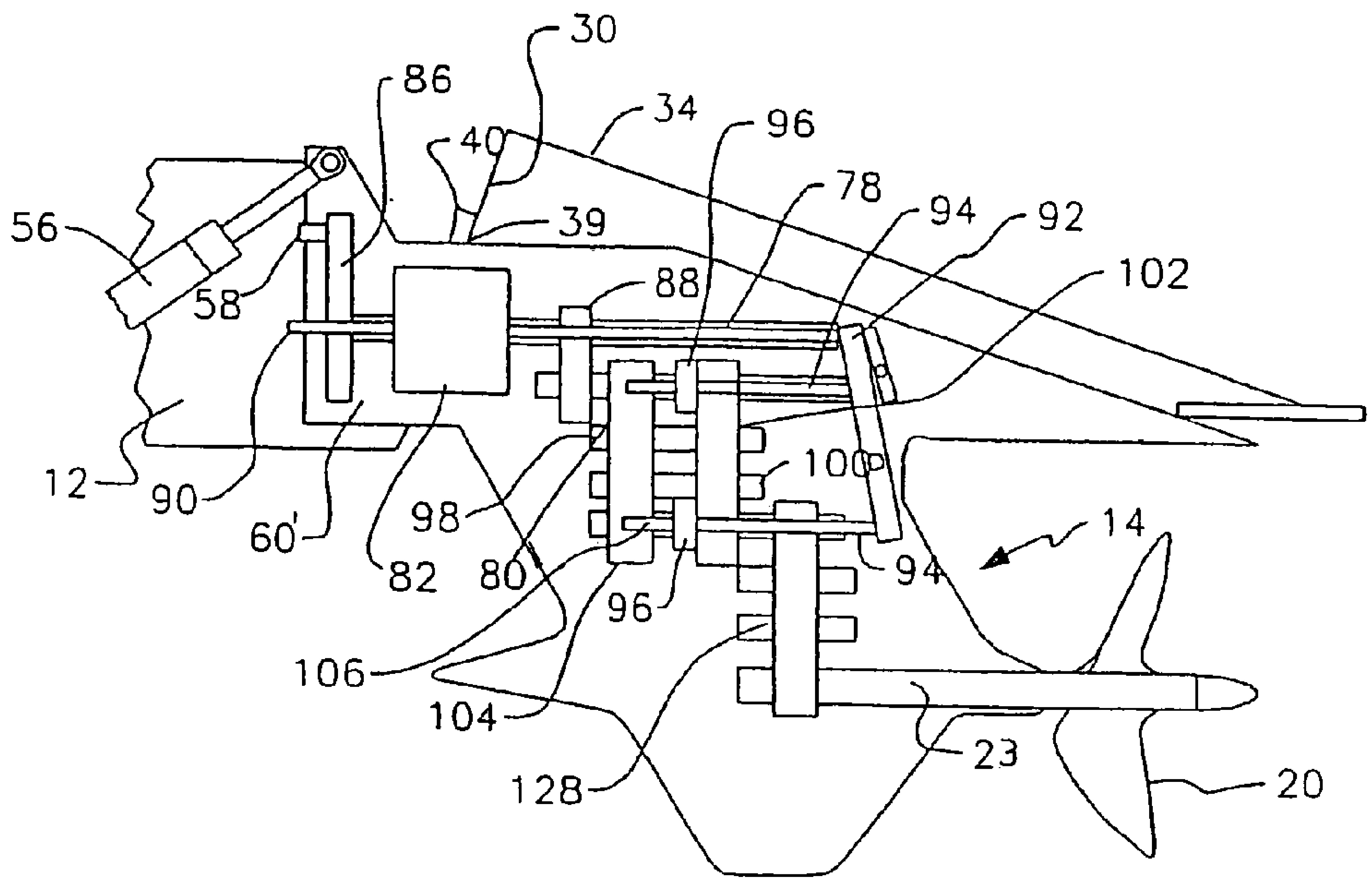

30
34
86
40
96
78
94
92
56
39
102
88
58
100
12
90
98
14
60'
80
94
82
96
106
104
23
128
20

FIG. 5B

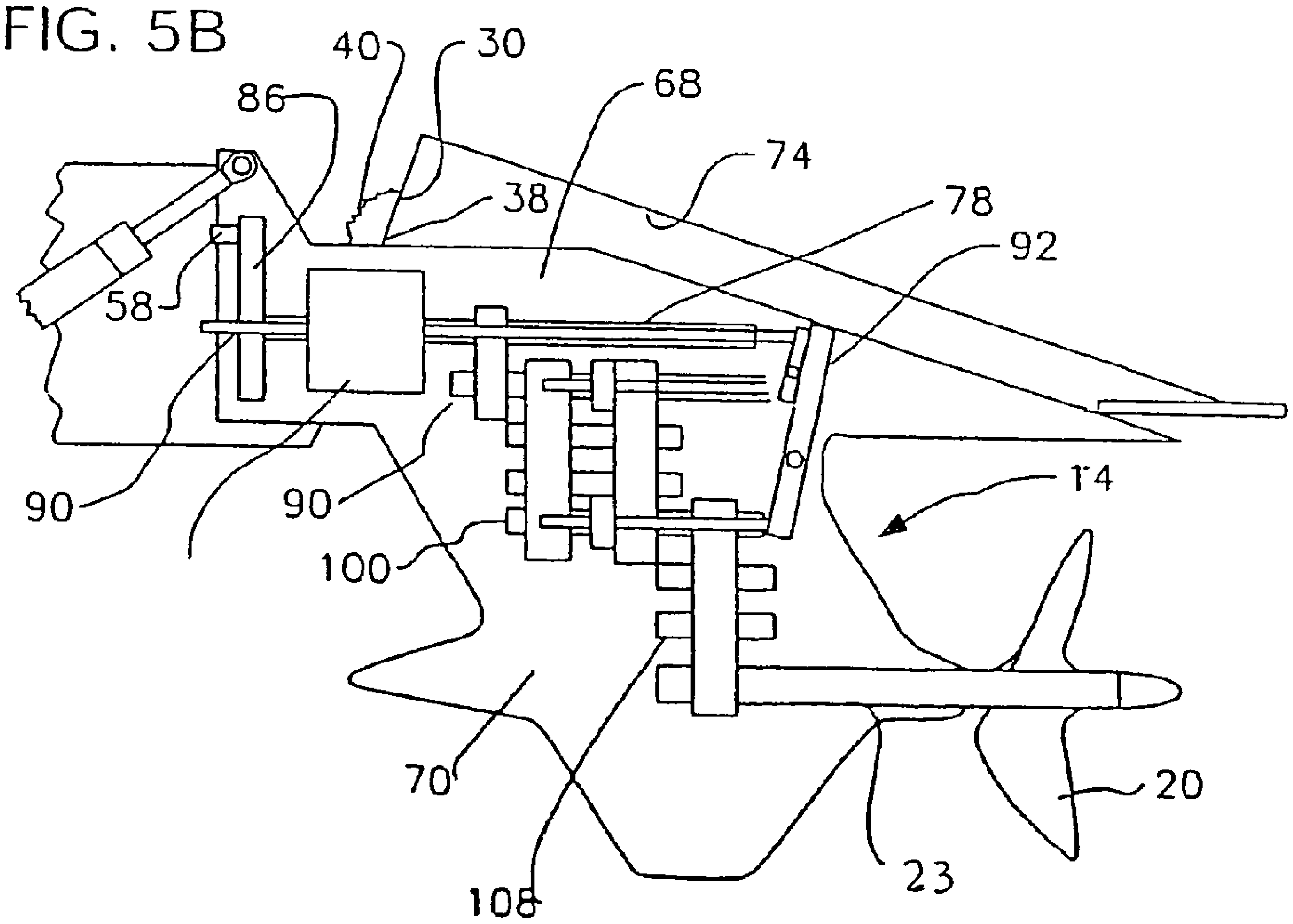
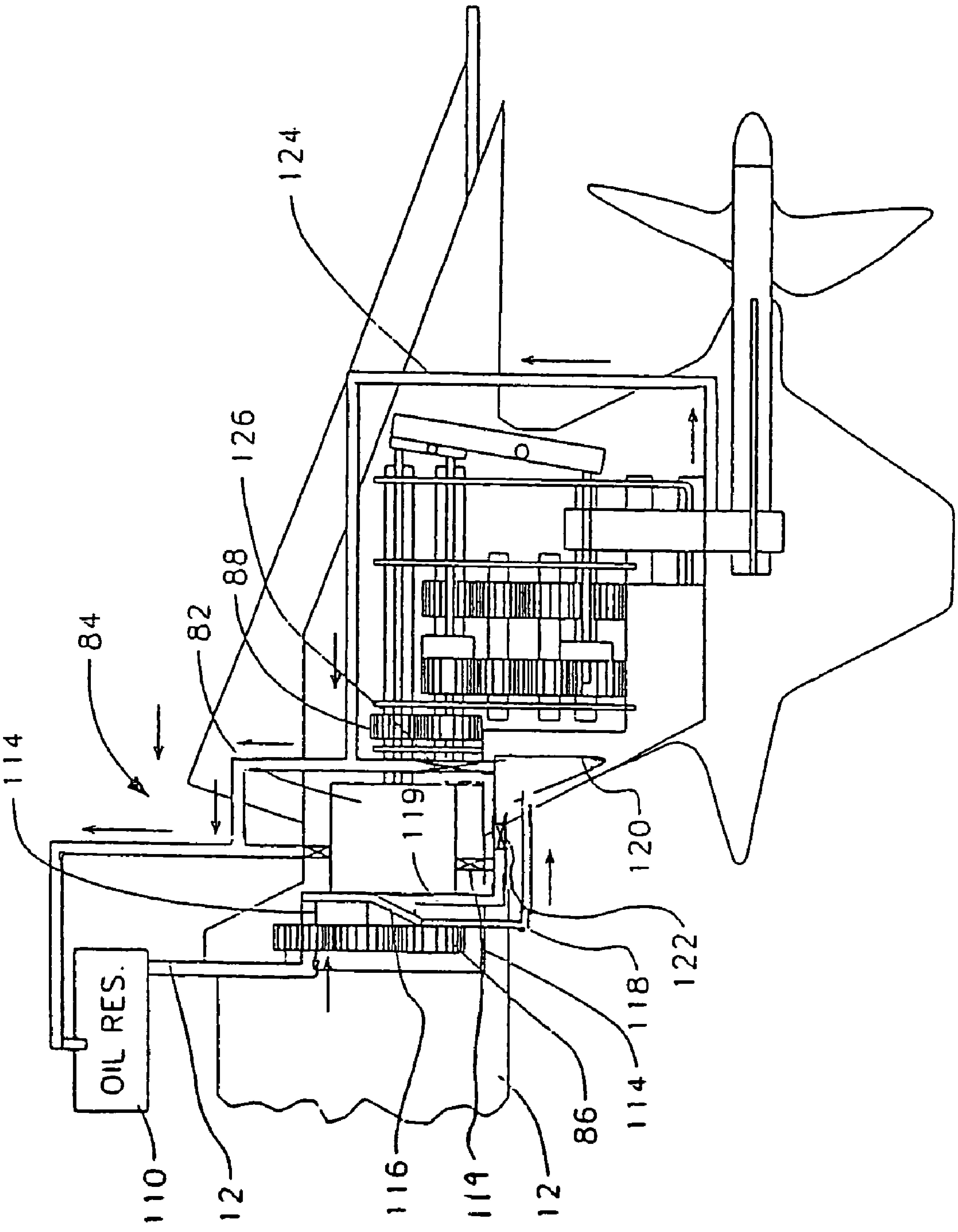

40
30
86
68
74
38
78
58
92
90
90
14
100
70
20
108
23

FIG. 6



OIL RES.
124
126
88
82
84
114
119
120
122
118
114
86
12
119
116
112
110

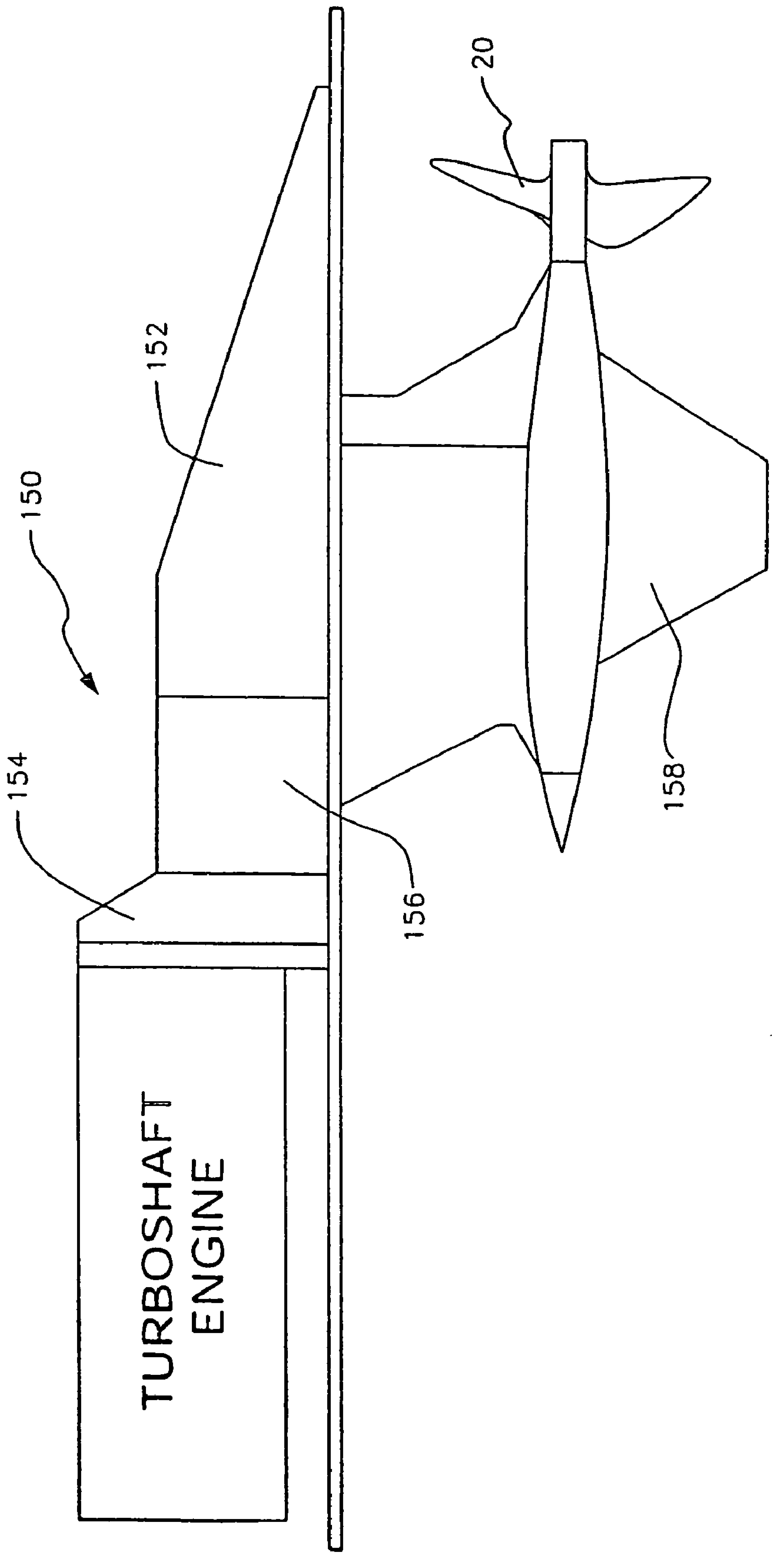


FIG. 7

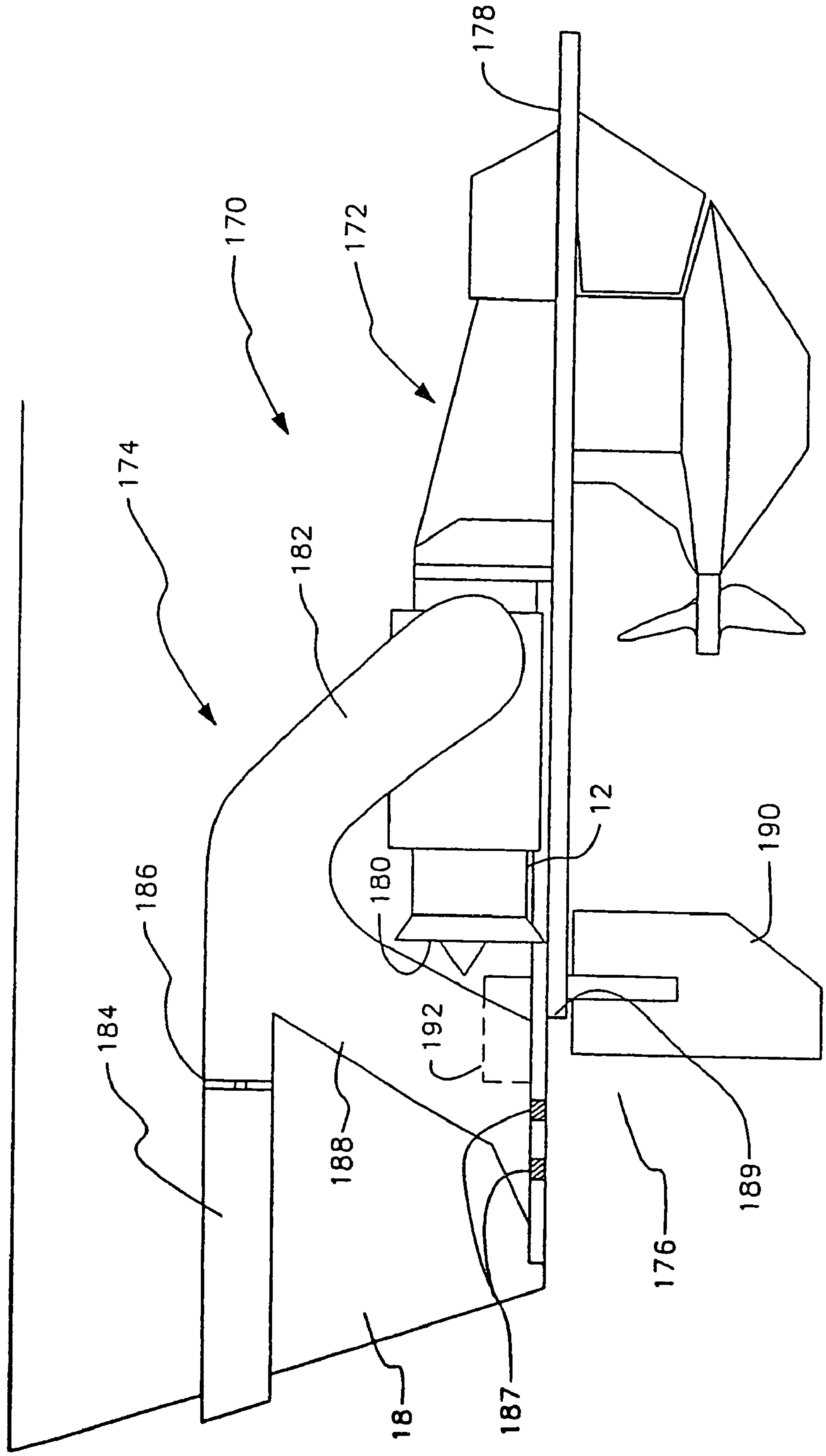
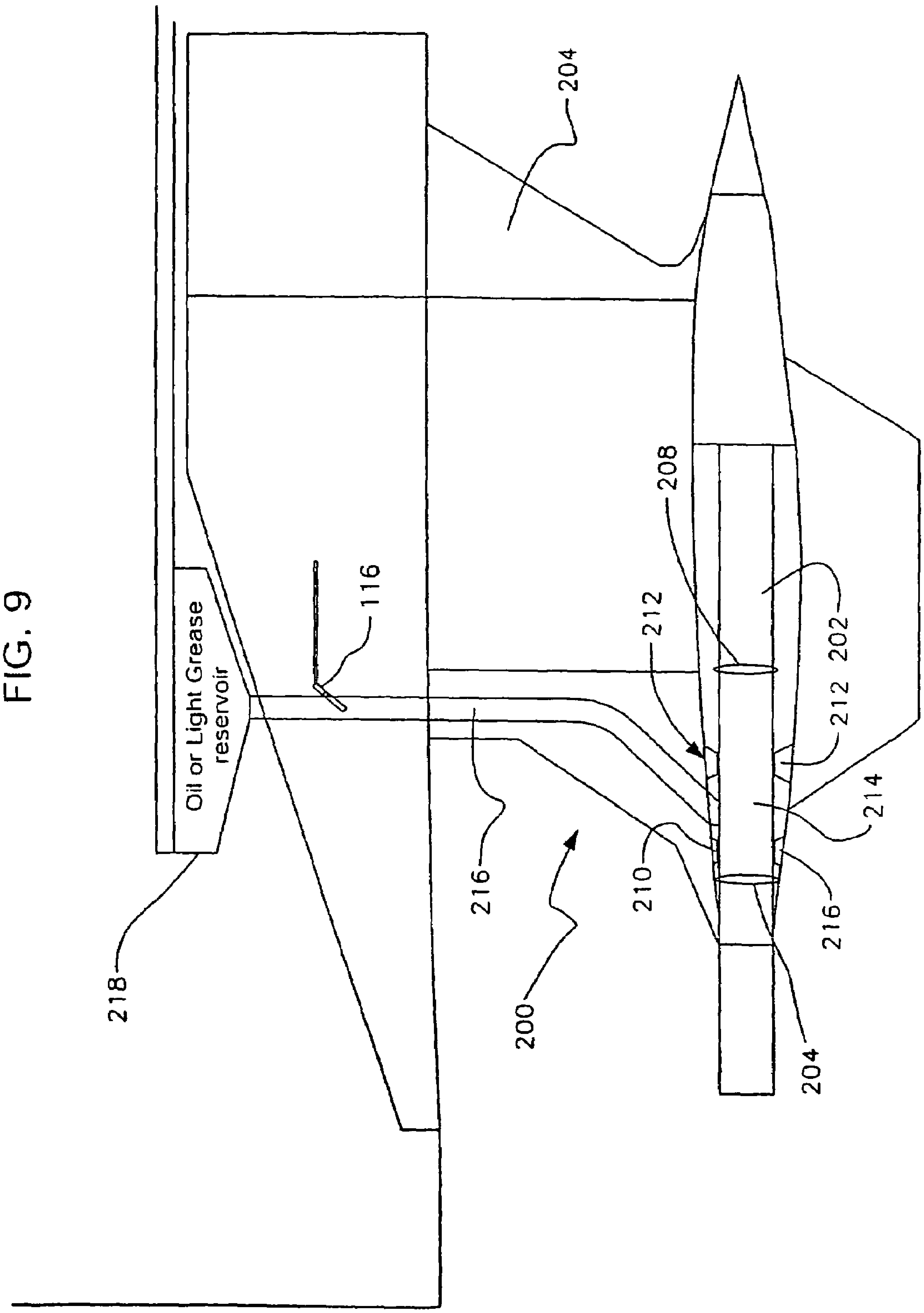


FIG. 8

FIG. 9


204
208
116
212
212
202
Oil or Light Grease reservoir
212
214
216
210
216
218
200
204
216

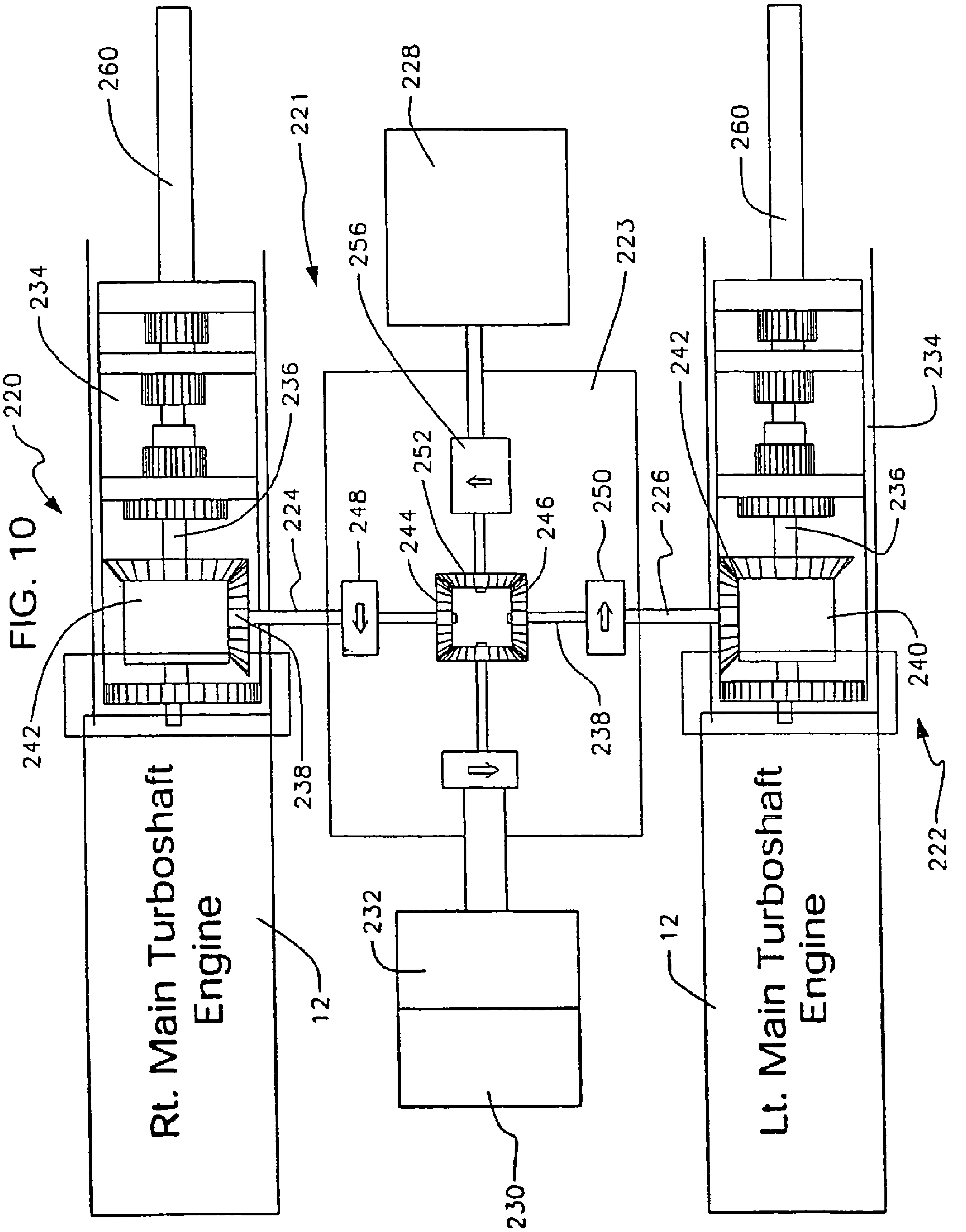

220
221
222
223
224
226
228
230
232
234
236
238
240
242
244
246
248
250
252
256
260
12
Rt. Main Turboshaft Engine
Lt. Main Turboshaft Engine

FIG. 10

MARINE PROPULSION UNIT

RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 10/476,951 filed May 11, 2004 now U.S. Pat. No. 6,902,448, which is a 371 of PCT/US02/14683 filed May 8, 2002, which claims priority of U.S. Provisional Application Ser. No. 60/289,352 filed May 8, 2001.

BACKGROUND OF THE INVENTION

Conventional inboard marine propulsion units utilize a shaft which extends through a packing gland and is angled downwardly and rearwardly and supported under the stern of the hull by a strut. The engine is mounted to the hull. Frequently, a transmission with universal joint is used to compensate for the position of the motor and transmission with respect to the angle of the shaft. It is also known to use outdrive propulsion units with inboard mounted engines. The engine is mounted to the stern and an outdrive is mounted to the transom of the boat. A universal joint connects the engine to the outdrive. The angle of the outdrive propeller may be varied with respect to the angle of the hull. The angle of the outdrive unit can be adjusted to maximize the efficiency of the prop for different speeds and water conditions. It would be desirable to provide an inboard propulsion unit which has the advantages of the outdrive unit which could be used in a variety of applications. Additionally, it would be advantageous to provide an easily installed propulsion system which does not require a universal joint.

SUMMARY OF THE INVENTION

A marine propulsion unit consisting of a drop-in module having an engine and a drive unit is disclosed. The unit is preferably a turbine shaft engine. The drive unit is mounted to extend through a base having an outer surface forming a portion of the hull. In a preferred embodiment, the propulsion unit is pivotally mounted to the base to permit angular positioning of the propeller with respect to the hull. In a first alternative embodiment, the propulsion unit is mounted to extend through the transom of the boat to provide an inboard/outboard application. The drive unit may be equipped with a rudder and steering assembly. The drive unit contains a novel arrangement of gears and shafts to provide a thin profile. A hydraulic resistance circuit provides resistance when the engine is running at an idle. The propulsion unit can be provided with a power transfer device for driving an auxiliary electrical power generator. The power transfer device also permits use of an auxiliary engine from a main electrical power generator to drive one or both of the main propeller shafts. Likewise, one main engine can drive one or both of the shafts. The engine of the electrical power generator can be used to drive the vessel for maneuvering at low speeds through an auxiliary drive shaft.

A second preferred embodiment of the invention includes a drop-in module having a propulsion unit fixedly mounted to the base. A third preferred embodiment of the invention includes a drop-in module having a rudder and steering assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a side view of a marine propulsion unit shown in a normal operating position in accordance with the preferred embodiment of the invention;

FIG. **1**B is a side view of a marine propulsion unit shown in a down position in accordance with the first preferred embodiment of the invention;

FIG. **2** is a top view of a marine propulsion unit in accordance with the preferred embodiment of the invention;

FIG. **3** is an exploded perspective view of a marine propulsion unit shown in accordance with the preferred embodiment of the invention;

FIG. **4** is a side view of a first alternative embodiment of the invention;

FIG. **5**A is a side schematic view of the drive unit in a forward gear in accordance with the preferred embodiment of the invention;

FIG. **5**B is a side schematic view of the gearing arrangement as shown in the reverse position;

FIG. **6** is a side view of the propulsion unit showing the lubricating and resistance circuit;

FIG. **7** is a side view of a second alternative preferred embodiment of the invention;

FIG. **8** is a side view of a third preferred alternative embodiment of the invention;

FIG. **9** is a side view of the propulsion unit and seal arrangement in accordance with the preferred embodiment of the invention; and

FIG. **10** is a top schematic view of the propulsion unit connected with a power transfer device power in accordance with the preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of a novel marine propulsion unit **10** which is suitable for inboard applications is shown in FIGS. **1**–**3**. The marine propulsion unit **10** may be easily installed in a boat and is particularly suited for use with turbine engines. However, other types of engines may be used. As best shown in FIGS. **1**A and **1**B, the propulsion unit **10** includes an engine **12** and a drive unit **14** which are joined together by a cowling **16** and mounted on a base **22**. In the preferred embodiment, the propulsion unit **10** is mounted to pivot with respect to base **22**. As will be discussed below, the pivotal mounting arrangement permits the angle of a propeller **20** to be adjusted upwardly and downwardly with respect to hull **18** of a boat as shown in FIGS. **1**A and **1**B.

As shown in FIGS. **1**A, **1**B, **2** and **3**, the propulsion unit **10** and base **22** are mounted as a unit in the hull **18**. The hull has a rectangular aperture extending through a bottom of the hull to receive the base **22**. The base **22** has a generally rectangular shape having a peripheral flange **24** which is formed to mount the base **22** to an inner surface of the hull. The base **22** is preferably formed of the same material of which the hull is formed, such as fiberglass, composite or aluminum. As shown in FIG. **1**A, the base **22** has a forward portion **26** which extends underneath the engine **12** and a tunnel portion **28** which covers a portion of the drive unit **14**. The forward portion **26** has a lower surface **27** which is conformed to the shape of the hull **18**. The lower surface **27** conforms such that after the base is installed, the lower surface flows continuously with the adjacent portion of the bottom of the hull. The sides of the base **22** closely conform to the shape of the aperture in the bottom of the hull. The tunnel portion **28** has an end wall **30**, a pair of side walls **32** and a top wall **34** which form a housing for receiving an upper portion of drive unit **14** when the drive unit is in the fully retracted position.

As shown in FIGS. **5**A and B, the forward portion of drive unit **14** extends through an aperture **38** formed in the end wall **30**. A flexible synthetic boot **40** which has sufficient flexibility to permit pivoting of the propulsion unit extends between the end wall **30** and drive unit **14**.

As shown in FIGS. **2** and **3**, the propulsion unit **10** is supported for pivotal rotation by a pair of arms **42** which extend between the drive unit **14** and the inner side walls of the base **22** along axis "h". The arms **42** are supported for rotation by bearings and the like which are mounted in the base. Electrical wiring may be carried to the engine through the arms **42**. Exhaust is carried from the engine by an L-shaped exhaust tube **43** which is pivotally connected to a sleeve **44**. The tubes **43** and sleeves **44** are tubular to form a passage for the exhaust system. Each sleeve **44** extends outwardly from one side wall **32** of the tunnel along the axis "h" which extends transversely across the hull. Each tube has an inner end **46** which passes through the cowling and is mounted to the exhaust ports (not shown) of the engine. Each arm has an outer end having a transverse bore **48** to receive the sleeve **44** therethrough. As shown in FIG. **3**, an elongated aperture **50** is formed in the sleeve to extend in an arc to receive exhaust from the tubes **43**. An inner surface **52** of the sleeve **44** is radiused to divert the flow of exhaust from the tube smoothly through the sleeve **44** to an exhaust pipe. Seals **54**, such as piston rings, are mounted within the transverse bore **48** of the tube **43** to maintain the exhaust within the tubes **43** and sleeve **44**.

The inner surface transverse bore **48** of the arm is formed to pivot on the outer surface of the sleeve **44** when the angle of the propeller shaft is adjusted. As shown in FIGS. **1**A and **1**B, a pair of hydraulic cylinders **56** extend on either side of the engine from the forward portion **26** of the base **22** to the cowling **16**. The hydraulic cylinders **56** are moveable to pivot the propulsion unit **10** on the arms **42** to pivot the drive unit **14** and propeller **20** upwardly and downwardly as a unit with respect to the bottom of the hull **18**.

As shown in FIGS. **2** and **3**, in the preferred embodiment the engine **12** is a turbine engine such as a Pratt and Whitney PT6 with an output shaft **47**. However, small gas or electric engines may also be used. Because the engine is lightweight, it may be hard mounted directly to the drive unit without the need for universal joints and the like. The cowling **16** extends between the engine **12** and drive unit **14**. The cowling **16** has an aperture **36** formed to receive an input end **60** of the drive unit **14**. At the opposite end of the cowling, two arms **62** extend longitudinally to extend above a rear portion of the engine **12**. Engine mounting blocks **64** are positioned between ends of each of the arms to mount the engine **12** to the cowling **16**.

As shown in FIGS. **1**A, **1**B, **5**A and **5**B, the drive unit has a housing **66** with an upper portion **68** which extends through the end wall **30** and into the tunnel **28** and a lower portion **70** which is hydrodynamically formed as a foil to support a propeller shaft **23** and propeller **20** near a lower end. The housing may be formed of metal or a composite material and has removable access covers **74** on the upper portion to permit access to the drive unit. A cavitation plate **76** is formed on the housing **66** to enclose the aperture beneath the tunnel when the propulsion unit is in its fully retracted position, as shown in FIG. **1**A. The cavitation plate **76** is radiused longitudinally to provide an upward curve. The curvature of the cavitation plate **76** permits clearance for pivoting of the drive unit with the base **22** and to provide a hydrodynamic flow beneath the tunnel.

As shown in FIGS. **5**A, **5**B and **6**, the upper portion of the drive unit houses an input shaft **78**, a shift rod **90**, clutch **82**, and a hydraulic resistance circuit **84** (FIG. **6**) for use when the engine is at idle. The input shaft **78** is connected to a drive shaft **58** of the engine **12** by a pair of reduction gears **86**. The main drive shaft **78** extends from the reduction gears **86** to the hydraulic clutch **82** and then to a drive gear **88** for a second reduction. As shown, the input shaft **78** is hollow to receive a shift rod **90** which extends through the drive shaft to a lever arm **92** which is connected to rods **94** connected to clutch dogs **96** on two intermediate shafts **98**, **100**. The shift rod **90** is formed in segments which are connected with ball bearings and races formed on the ends of the rod to permit relative rotation between the shift rods **90** and the lever arm **92**. This is necessary because the shafts carrying the gears are rotating and clearance permits the shift rods to rotate with the gear shafts. The two intermediate shafts **98**, **100** are mounted in parallel arrangement between the main input shaft **78** and the propeller shaft. They are connected together by vertical aligned sets of gears **102**, **104**. One set of gears **102** provides a forward drive and has four gears in a vertical arrangement. The set of reverse gears **104** has five gears, including a reverse gear which is offset on a shaft just beneath the first intermediate shaft **98**. The vertical sets of gears are used to provide a very thin side-to-side profile for the foil portion of the housing. Thus, power is transferred downwardly without using large diameter gears. Movement of a shift cam at one end of the main drive shaft engages the hydraulic clutch **82** to drive the main drive shaft **78** and the second driven gears **88**. At the same time, the lever arms **92** are moved to move the clutch dogs **96** on the two intermediate shafts **98**, **100** to engage one of the two sets of gears **102**, **104** corresponding to either forward or reverse direction. These gears then in turn drive the second drive shaft **106** to turn a final set of gears **108** which extends downwardly to connect with the gear mounted on the propeller shaft **22**.

As shown in FIG. **6**, a hydraulic resistance circuit is formed within the drive unit **14** to provide resistance to the engine **12** when the engine is idle. Turbine engines will accelerate when at idle unless a load is placed on the engine. Hydraulic oil from an oil reservoir **110** is delivered to the first set of reduction gears **86** through conduit **112**. The gears **86** are mounted in a housing in the same fashion as a hydraulic gear pump. The hydraulic fluid is pressurized as it passes around the gears **86** and delivered to an outlet **114**. A valve **116** is moved by the shift rods **90** between a resistance passage **119** when the engine is at idle and a delivery passage **118** when the drive unit is in gear. This movement of the shift linkage controls gear selection, clutch, clutch dogs, and hydraulic resistance. The pressurized fluid is then delivered through the resistance passage **119** to a restrictor **121** with a pressure relief valve and to the clutch to release the clutch dogs. The fluid is also delivered to a resistance restrictor **122** and to a radiator **120**. The resistance restrictor **122** develops resistance in the circuit developing a hydraulic load in opposition to the reduction gear and engine to prevent acceleration when the engine is at idle. However, because the work generated by the resistance in the restrictor **122** causes heat in the hydraulic fluid, fluid is passed through the radiator **120** formed in the lower front portion of the foil to cool the fluid before it is delivered back to the other gears and to the tank. When the gears are engaged and the valve **116** moved, the oil passes through the delivery passage **118** to the radiator **120**, the clutch **82** to engage the clutch dogs and through the gear sets. A return passage **124** permits return of the fluid to the reservoir. A pressure relief valve is provided to prevent pressure build up in radiator **120**.

As shown in FIG. **4**, a first alternative embodiment of the invention provides a propulsion unit **127** installed for use as an inboard/outboard unit. The propulsion unit **127** is pivotally mounted to the transom **129**. The propulsion unit **127** includes the engine **12** and a drive unit **128** as above. As discussed below, the drive unit **128** includes a rudder **142**. Alternatively, the propulsion unit may include drive unit **14** which does not have a rudder. The drive unit **128** extends through a vertically aligned slot **130** in the transom **129** and boot **132**. The propulsion unit **127** may be mounted to a vertical lift mechanism on both sides at the pivot axis. A hydraulic cylinder **136** or lead screw arrangement is used to raise or lower a yoke **134** and the propulsion unit **127** within the slot **130**. The boot/seal cover **132** permits the propulsion unit to be moved with the slot **130**. A pivot mechanism such as a hydraulic cylinder **135** or suitable device is mounted between the yoke **134** and propulsion unit **127** to pivot the propeller **20**. Alternatively, propulsion unit **127** may be pivotally mounted directly to the transom without the lift mechanism. In this case the pivot mechanism extends between the transom and propulsion unit.

As shown in FIG. **4**, the drive unit **128** may be provided with a rudder **142** which is mounted to extend beneath the end of the cavitation plate **76**. The rudder **142** has a longitudinal tongue and groove arrangement **138** to permit the rudder **142** to be slid in for quick change in case of damage or to facilitate performance. A conventional hydraulic steering unit **140** is used to turn the rudder. The drive unit **128** is particularly suited for use with any high performance boat.

As shown in FIG. **7**, a second preferred embodiment of the invention includes a propulsion unit **150** which does not pivot. The engine **12** is connected to a drive unit **152** by the cowling **154** as described above. The drive unit **152** includes a housing **156** and a lower drive unit **158** having a propeller shaft and propeller **20**. The housing **156** contains the transmission and parallel gear shaft arrangement discussed above. The fixed propulsion unit **150** is mounted to base **160** by extending the housing **156** through an aperture formed in the base **160** and securing the housing **156** of the drive unit to the interior of the hull.

A third preferred alternative embodiment of a propulsion unit is shown in FIG. **8**. The propulsion unit **170** includes the turbo shaft engine **12**, drive unit **172**, exhaust system **174** and a rudder steering assembly **176** mounted to a base **178** to form a "drop-in" module as above. The propulsion unit **170** is compact and lightweight. The engine **12** is mounted to have the air intake **180** open rearwardly and the drive unit **172** forwardly mounted ahead of the engine **12** in reverse of what is disclosed for the propulsion unit **10** described above. Accordingly, the gear setup is such that the propeller shaft and propeller extend in an opposite direction from the drive unit **14** disclosed above. However, the gear arrangement, shift linkage, etc. is the same. The exhaust system **174** includes an exhaust manifold **182** which extends rearwardly and upwardly to an upper exhaust pipe **184** having an idle relief valve **186** for engine start and off plane operation. A main exhaust pipe extends upwardly from the base **178** to the exhaust manifold **182**. Exhaust is delivered by ports **187** in the base to the low pressure area behind the rudder **190**. The low pressure area is formed by a step **189** in the hull to create a pressure drop in the water flow when the boat is moving sufficiently.

The rudder **190** and steering assembly **192** are mounted to the base **178** so that the engine, drive unit, exhaust system and rudder form a single module which may be dropped into an aperture formed in the hull of the boat. The base **178** has a bottom which is conformed to the exterior shape of the hull as above. After the module is mounted in the boat, the engine is connected to the fuel tankage, electrical power and control system, coolant, etc. which are installed in the boat.

The drive unit is equipped with a novel propeller shaft seal system **200** as shown in FIG. **9**. The propeller shaft **202** is mounted in a drive unit **204** with outer and inner water seals (**206**, **208**). Between the outer seal **206** and inner seal **208** are two sets **210**, **212** of labyrinth type seals which are spaced apart on the shaft to form a grease cavity **214**. A conduit **216** delivers oil or light grease from a reservoir **218** to the grease cavity. When the engine is running, low pressure bleed air is delivered to the reservoir **218** to pressurize heavy oil or light grease in the reservoir **218** and conduit **216** and grease cavity **214**. The pressurized oil or light grease always in the grease cavity **214** tends to push any water out of the cavity **214** and keeps the cavity **214** full of grease to displace any water.

As shown in FIG. **10**, an auxiliary drive system **221** permits the main propulsion units **220**, **222** to drive an auxiliary electrical power unit **228** through a power transfer device **223**. The auxiliary power unit **228** is used to provide electricity for the boat and is typically a 110 volt AC system. A main electrical power unit **230** with a separate engine **232** is connected to the power transfer device so that electricity may be produced when the main power engines **12** are not being operated. The main propulsion units **220**, **222** are connected to a power transfer device **223** by auxiliary drive shafts **224**, **226**. The auxiliary drive shafts **224**, **226** are selectively connected to a drive shaft **236** of drive unit **234** by a clutch **240** and a pair of bevel gears **242**. The clutches selectively deliver the power of each of the main propulsion units **220**, **222** to the power transfer device **223**. The auxiliary shafts **224**, **226** are selectively coupled to bevel gears **244**, **246** by clutches **248**, **250** to drive bevel gears **252**, **254**. The drive bevel gears are connected by coupling devices **256**, **258** to the main power unit **230** and auxiliary power unit **228**. The coupling device **256** is operable by hydraulic power diverter to deliver a selected rpm to the auxiliary power unit **228** so as to run the power unit **228** at its optimal speed. The power transfer device **223** permits use of one main power unit to drive both shafts **260**. Alternatively, one or both main power units may be used to drive the auxiliary power unit **228**. Typically, turbine engines are more fuel efficient when run at higher power settings and are not as fuel efficient at low power settings. The power transfer shafts allow the main power units to be powered by auxiliary engine **232** for fuel efficiency during slow speed off-plane operations. The auxiliary engine additionally drives the alternator or alternators. A single turbine at 100% power is much more fuel efficient than two engines at 50% power. The output of the diesel is governed to run at a constant rpm to enable full capacity of the alternator or alternators. A hydraulic coupling with an output control is used with the main propulsion systems to power the auxiliary generator so that the alternator is run at a constant rpm.

Each drive unit can be powered independently by its respective turbine engine for high performance operation. Either turbine engine may also be used to power the second alternator, as a back up should the diesel engine fail. Finally, the auxiliary engine may be connected through the power transfer device to power one or both of the left and right drive units **234** and propellers. Because turbines engines are not particularly efficient at low speeds, the auxiliary engine **232** can be used to drive the boat through the propulsion unit or units at low speeds such as maneuvering in marinas and waterways. At high speed both of the main engines are used to drive the boat.

Having thus described the invention, many modifications and other embodiments are contemplated and within the scope of the invention.

The invention claimed is:

1. A marine propulsion system for a boat having a hull having a bottom, said system comprising:

an engine;

a power transfer device operatively connected to said engine and mounted within the hull, said power transfer device having a drive shaft extending transversely to said hull and having a pair of ends; and

a pair of propulsion units, each of said pair of propulsion units extending through the bottom of the hull and having a drive unit having a propeller shaft and a propeller; each of said pair of propulsion units operatively connected to one end of said drive shaft within said hull, said propulsion units mounted to said boat such that said propulsion units pivot about said drive shaft thereby changing the angle of said propeller shaft with respect to said hull.

2. The marine propulsion system of claim **1** wherein each propulsion unit further comprises a housing tunnel and a lower portion which is hydrodynamically formed as a foil.

3. The marine propulsion system of claim **1** wherein each end of the drive shaft has a bevel gear connected to one of said pair of propulsion units.

4. The marine propulsion system of claim **1** wherein said power transfer device has a pair of clutches for selectively connecting said drive shaft to one or both of said pair of propulsion units.

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